THE ORIGAMI OF BOTANY: A GUIDE TO COLLECTING AND MOUNTING SPECIMENS OF CYCLANTHACEAE[1]

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ABSTRACT

Guidelines for preparing and mounting specimens of Cyclanthaceae, as well as a key to the genera, are presented in order to facilitate collecting of a difficult and often neglected family. In general, specimens should be prepared so the depth of the leaf division is apparent and the lower surface of the basal part of the leaf is visible or accessible.

The family Cyclanthaceae has far fewer species than the other related families of large intractable monocots for which guides to the preparation of herbarium specimens have recently been published (Croat, 1985; Dransfield, 1986; Stone, 1983). Nevertheless, in much of the wet lowlands of the Neotropics the cyclanths form a very conspicuous element of the understory and epiphyte flora (Figs. 1, 2). Careful collecting in almost any area of wet primary forest often yields new species because the family is poorly represented in herbaria and many species are narrowly endemic. This paper is a call for more collections as well as a guide to help insure that they be properly prepared.

SPECIMEN SELECTION AND PREPARATION

How to find them. Cyclanths are often left uncollected due to their large size, epiphytic habit, ephemeral and seasonal flowering, and green fruits. Moreover, the fertile structures are born low on the plant and are overtopped by obscuring leaves (Fig. 3). However, even in a population that is out of season, examination of numerous plants will often reveal fertile structures. This effort is important. Both staminate and mature fruiting materials are essential for describing new species and often for identifying known species.

Dramatic—though nearly microscopic—differences in floral and fruit structure between vegetatively similar species are easily overlooked by the nonspecialist collector who may tend to "see" (and collect) only one common species of a genus in an area where three or four occur. Different species may occupy the same habitat on adjacent ridges or along different branches of a single stream. Differences in depth of lamina division, presence/absence and position of lateral costae, phyllotaxy, habit, and even subtle differences in lamina and petiole texture and color help reveal different taxa.

What to do to them. The artful folding (origami) of whole plants of large-leaved monocots may in itself be reward enough for a specialist in the particular family, but one can hardly expect specialists in other groups or even generalist collectors to spend so much time on one gathering. The final specimen is usually better for data recovery when redundant material has been removed and the essential properly folded. Thus, the first need in collecting large-leaved monocots is to know what parts of the plant to collect. Most of the following comments pertain to vegetative parts because most of the difficulties stem from them.

Since the leaves of cyclanths are bilaterally symmetrical, they can be split down the middle (Fig. 4). In general, the whole petiole and a piece of stem with attached inflorescence or infructescence should be included. Even when whole or half leaves are collected, two sources of information are often obscured or lost: the depth of division of the leaf and an abaxial view of the blade. It is not sufficient simply to press leaves so that the division is visible, since it often splits deeper on drying. On large leaves, which must be split to fit the press, the point of division can be indicated by cutting a notch at this point and folding the leaf so that the notch shows (Fig. 5). For leaves small enough to press entire, the best way to avoid ambiguity is to cut off one leaf lobe at the point of division (Fig. 6). The label should briefly record this notching and lopping of lobes,

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FIGURES 1, 2.—1. Dense understory of *Asplundia uncinata* Harl. in the wet lowlands of northeastern Costa Rica. Plants ca. 1.5 m tall.—2. *Evodianthus funifer* (Poit.) Lindman, a very widespread root-climbing epiphyte. Leaves ca. 50 cm long.

e.g., "notch marks point of division," or "lobe cut off at point of division."

The presence/absence and position of lateral costae is taxonomically meaningful at species and higher levels. Although these costae are very conspicuous on the lower surface, they are not visible at all from above. Thus, the blade should be folded to show at least the basal portion of the abaxial surface. This is true in all genera except *Carludovica,* and a few species of *Asplundia,* where features on the *upper* surface become important.

SPECIFIC (AND GENERIC) CONSIDERATIONS

The following key to the 10 genera of Cyclanthaceae is presented to facilitate discussion of generic characters and the requirements for collecting and mounting each genus. *Pseudoludovia,* no longer accepted, is not included in the key, nor are two new genera (R. Erikson, pers. comm.; Hammel & Wilder, in prep.), which require no special techniques.

FIGURE 3. The most conspicuous fertile stage, when the staminodia are exserted, is ephemeral and hidden among the leaves. Leaf blades ca. 65 cm long.

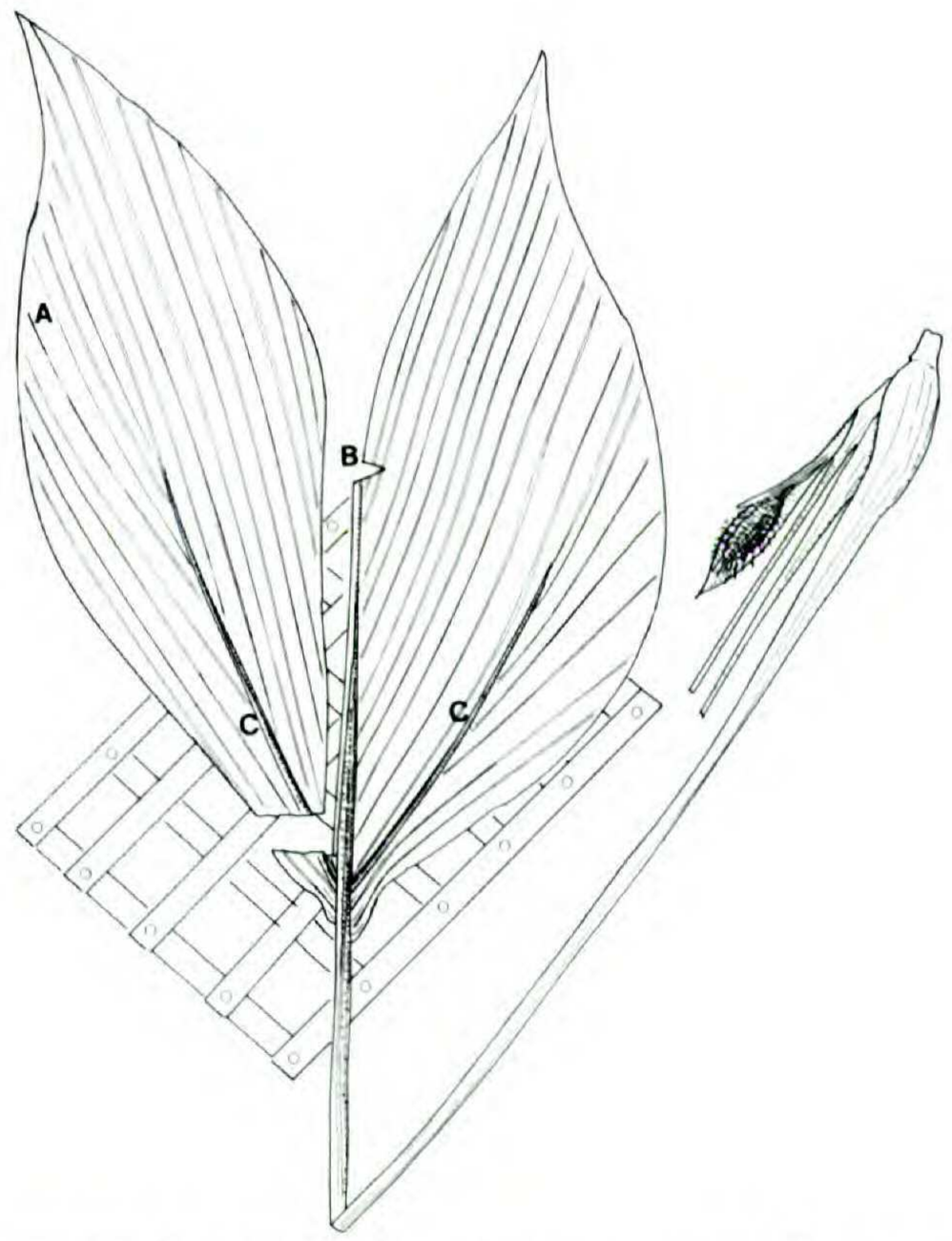

FIGURE 4. *Asplundia* specimen ready for pressing.—A. Section to be discarded.—B. Notch to mark depth of division.—C. Lateral costae.

KEY TO THE GENERA OF CYCLANTHACEAE WITH EMPHASIS ON VEGETATIVE CHARACTERS

1a. Leaf blades with the 2 major lateral costae running nearly the entire length of the blade, usually deeply bifid nearly to the base; spadix a cylinder of rings or spirals or both formed by alternating staminate and pistillate units; plants terrestrial, usually short-stemmed ..... *Cyclanthus*

1b. Leaf blades with the 2 lateral costae (if present) always disappearing well below the tip of the blade, entire to deeply divided; spadix a cylinder or sphere of tightly packed and variously connate to free, but more typical staminate and pistillate flowers; plants epiphytic, lithophytic, or terrestrial, often long-stemmed.

2a. Petioles mostly 1.5–3 m long; leaf blades palmately divided into 4 segments, the segments deeply toothed, the lateral costae short and far removed from the margin; plants terrestrial; surface of the mature spadix splitting irregularly to reveal the bright orange seed pulp and rachis; seeds angular ..... *Carludovica*

2b. Petioles mostly less than 1 m long; leaf blades usually entire or bifid, the segments rarely toothed but then the lateral costae long and running in the margin; plants terrestrial, epiphytic, or lithophytic; surface of mature spadix not splitting irregularly; seeds flat or terete.

3a. Leaves with 2 conspicuous lateral costae about as thick as the median costa (often in *Asplundia*, rarely in *Dicranopygium*, always in the monotypic *Schultesiophytum*).

4a. Spathes mostly dispersed along the peduncle; fruits dehiscent by apical caps, fused at the base ..... *Asplundia*

4b. Spathes clustered just below the spadix; fruits indehiscent.

5a. Leaves bruising and drying black; fruits completely separate ..... *Schultesiophytum*

5b. Leaves remaining green; fruits connate in basal ½ or more ..... *Dicranopygium*

3b. Leaves without conspicuous lateral costae.

6a. Spathes clustered immediately below the spadix.

7a. Plants long-stemmed and openly branched, usually climbing; stems and dry leaves scabrous; fruits completely separate; seeds flat ..... *Evodianthus*

7b. Plants mostly short-stemmed and clumped, rarely climbing a short distance, usually growing on rocks along streams; stems and dry leaves smooth; fruits connate in basal ½ or more; seeds terete ..... *Dicranopygium*

6b. Spathes dispersed along the peduncle.

8a. Leaves distichous.

9a. Leaf blades crenate at most, never bifid; fruiting spadix nearly smooth, the pistillate flowers connate throughout; plants lianas or short-stemmed epiphytes ..... *Ludovia*

9b. Leaf blades of mature individuals bifid; fruiting spadix not smooth, the pistillate flowers completely or partly free; plants terrestrial or epiphytic, usually short-stemmed.

10a. Seeds mostly rounded at both ends ..... *Sphaeradenia*

10b. Seeds with long appendages at both ends ..... *Stelestylis*

8b. Leaves spirally arranged.

11a. Petioles lacking, the broadly channeled false petioles (sheaths) extending to the blade; leaves of climbing stems often undivided; mature fruits tan; spathes 8–11; plants lianalike canopy climbers ..... *Thoracocarpus*

11b. Petioles present in most species, the false petioles narrowly channeled when present; leaves of climbing stems divided; mature fruits usually orange or green; spathes 2–8; plants low trunk climbers or terrestrial ..... *Asplundia*

Asplundia and *Dicranopygium* account for over half the species in the family, and it is within these two genera that variation in lateral costae is significant for distinguishing species. The requirement to show at least the basal portion of the lower leaf surface applies especially to these genera. For the small-leaved species of *Asplundia* it is important to insure that more than one leaf is preserved and that *both* surfaces of the basal part of the leaf are visible. This is necessary in order to see adaxial scars at the distal end of the false petioles, characteristic of several species in subgenus *Chaonopsis*. In *Asplundia* and *Dicranopygium*, whether or not the sheath splits up into fibers and the color and quality (dull vs. shiny) of its surface are necessary data points for identifying or characterizing species. Here, specimens should preserve a portion of the stem together with the leaf at its point of attachment.

Although *Sphaeradenia* consistently has only the median and no lateral costae, nothing is lost by preparing specimens of this genus (and of most others) as for *Asplundia* and *Dicranopygium*. In any case, for *Ludovia*, *Sphaeradenia*, and *Stelestylis* one should preserve part of the stem with attached sheaths in order to verify the distichous arrangement of the leaves and to show internode length (Fig. 6). *Asplundia*, *Dicranopygium*, and

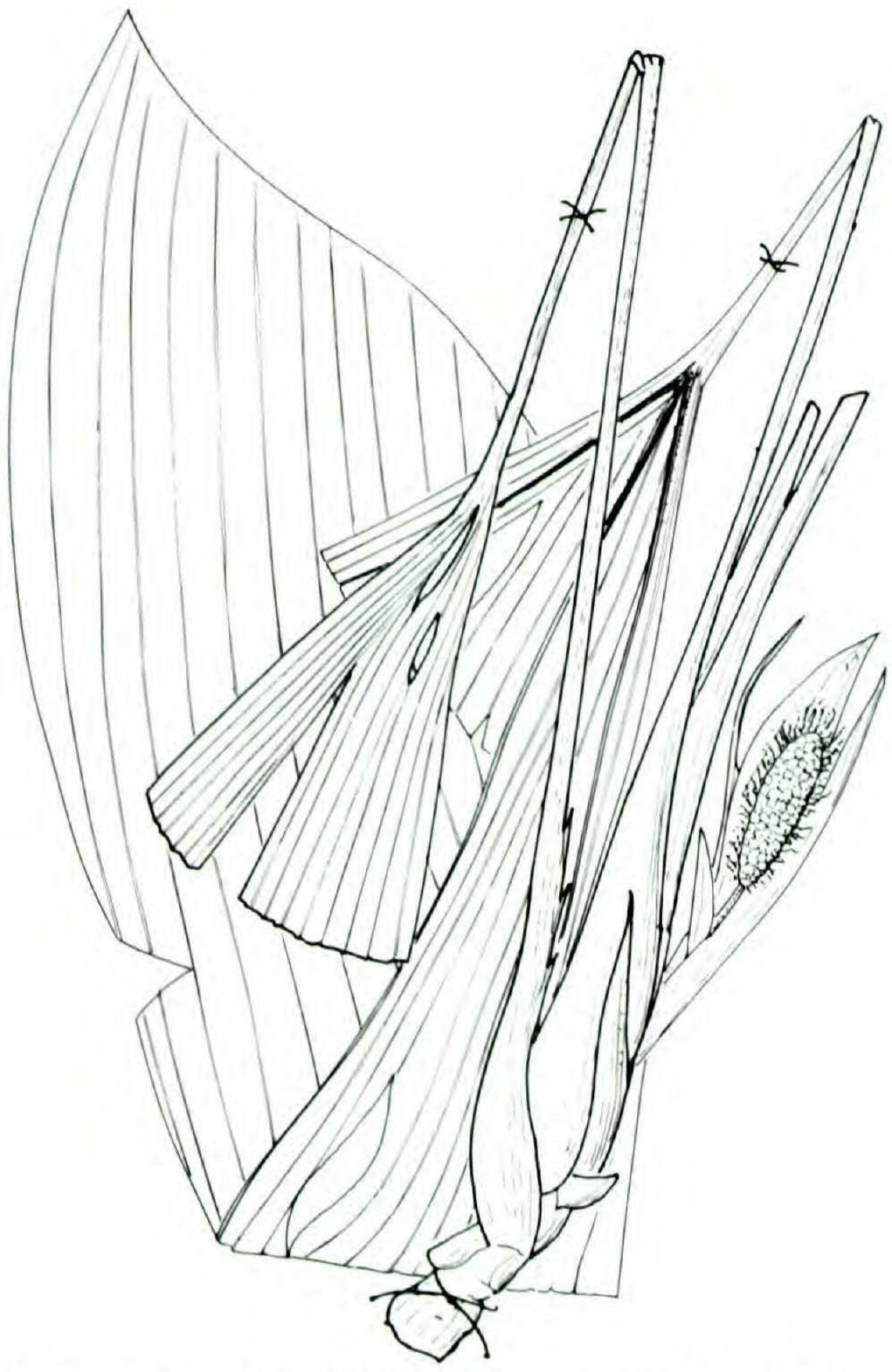

FIGURE 5. *Asplundia* specimen properly folded and mounted with string.

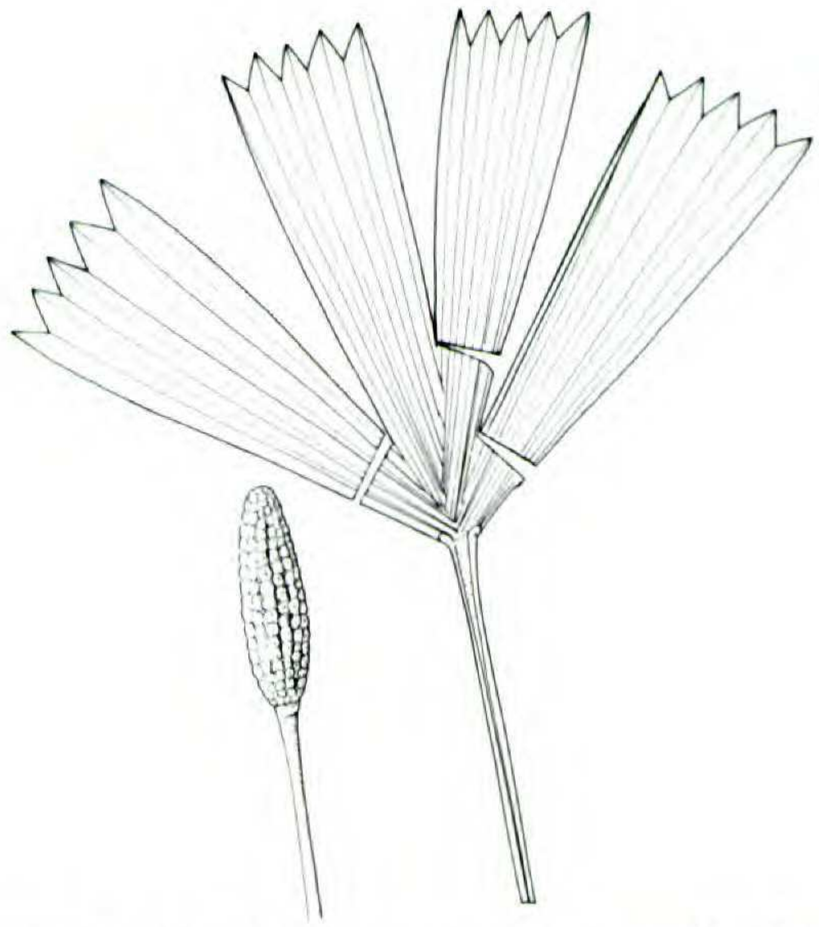

FIGURE 7. *Carludovica* specimen ready for pressing, showing sections to be discarded cut at point of division.

Sphaeradenia account for most of the species in the family so that the general rules for collecting these genera apply to most of the species one encounters.

Carludovica needs special attention in connection with the very large size and unusual shape of its mature leaves. In order to represent the essential features (the depth of the teeth and the

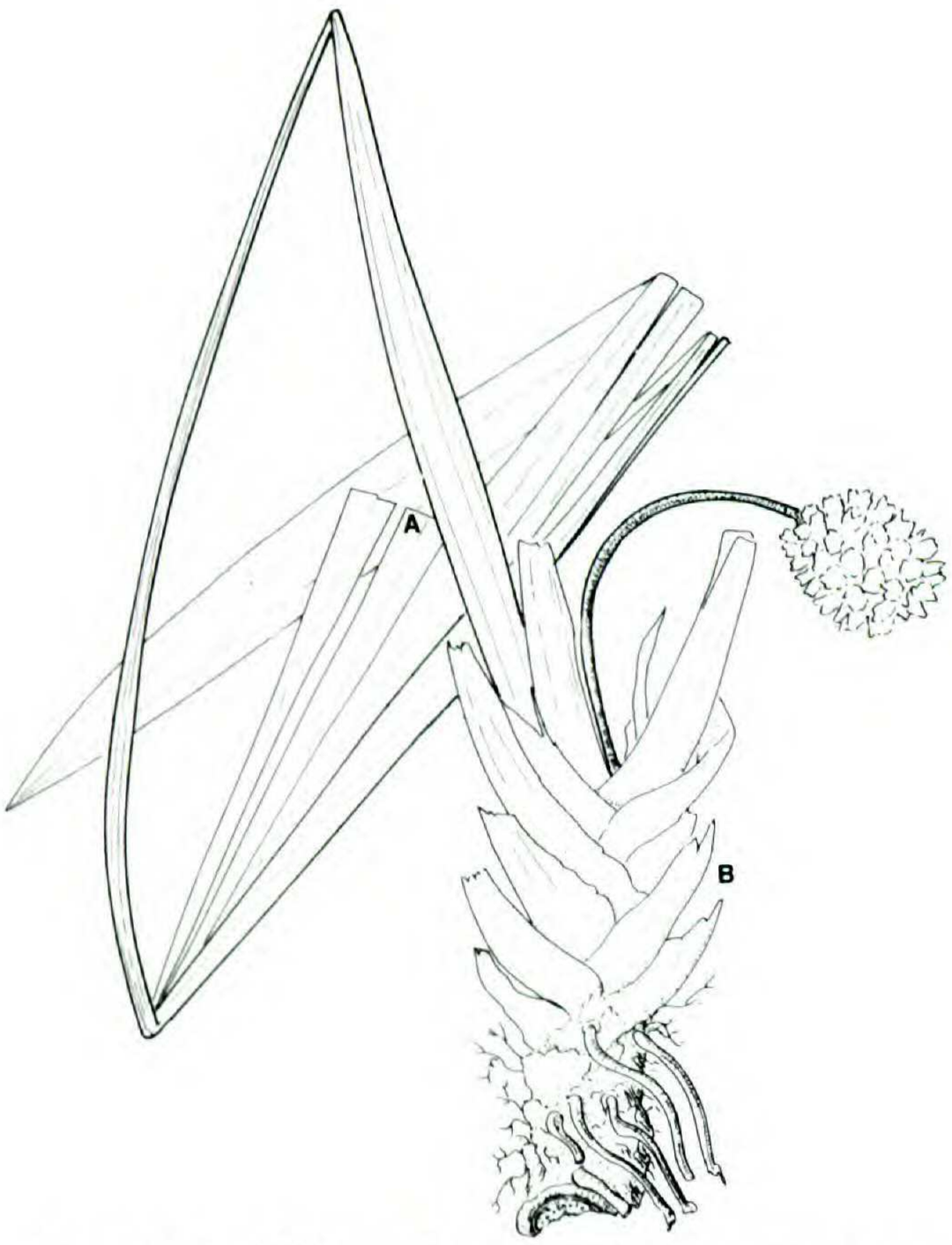

FIGURE 6. *Sphaeradenia* specimen showing blade cut off at point of division (A) and distichous phyllotaxy (B).

FIGURE 8. *Carludovica* specimen properly folded and mounted with string, showing hastulae (A) on upper surface.

depth of the divisions) only one of the four leaf segments need be preserved. The best approach is to cut off the two lateral segments and one of the central segments at the point of division and then fold the blade so that the teeth and the *adaxial* surface of the basal portion of the leaf are visible (Figs. 7, 8), thus showing the presence/absence of hastulae (Wilder, 1976). Sometimes even this reduced leaf must be split to fit on one sheet. Variation in petiole and peduncle length appears to be of little use for distinguishing species of *Carludovica,* but the length of these structures should at least be recorded in the field notes. Finally, for *Carludovica,* variation between species in shape of juvenile and immature foliage makes leaves from young plants worth preserving.

Field Notes

Habit. Approximately 60% of the species of Cyclanthaceae are either strict epiphytes or root-climbers, which may eventually lose connection with the ground. Habit is quite diverse (and sometimes variable within species) in *Asplundia* and *Dicranopygium.* The longest-stemmed species are usually found only as climbers, some with shorter stems climb or grow free-standing, and the shortest-stemmed species never climb. Strict epiphytes occur only in *Ludovia, Sphaeradenia,* and *Stelestylis,* and terrestrial species occur in all of these genera. *Carludovica* is always terrestrial; *Cyclanthus* rarely climbs. Only species of *Dicranopygium* grow on rocks along streams. For these reasons one should always make careful note of the habit: epiphytic, lithophytic, terrestrial, or root-climbing. If the collector is certain that a species is both terrestrial and climbing, it is very useful to write that in the notes, e.g., "apparently same species also climber here but not fertile." If the stem is not preserved, the leaf arrangement should be noted. The approximate length of the stem or height above ground for climbers (e.g., "climbing to 10 m") should also be recorded.

Other vegetative characters. Even though care has been taken to record on the specimen the depth of the leaf division, it is also a good idea to record in the field notes the approximate range of this character based on the plant or population collected, e.g., "leaves divided from ½–⅔." The leaf segments of all species of *Carludovica* and a few species of *Asplundia* develop teeth in the unopened leaf. Unfortunately, with age, drying, or other trauma some large *Asplundia* leaves can split into teeth, which on herbarium sheets resemble those arising developmentally. Thus, for *Asplundia* one should indicate whether such teeth originate developmentally or by trauma.

As noted above, subtle differences in leaf and petiole surface textures and colors often separate species and should be recorded. In a few species of *Asplundia* and *Dicranopygium* the leaf folds are not adaxially keeled. Because all leaves on herbarium specimens appear to have variously keeled folds, it is best to record exceptions in the field notes.

The cross-sectional petiole shape is less variable in the Cyclanthaceae than in certain genera of Araceae (Croat, 1985), but again this feature is difficult to assess using dried herbarium material and should be described for unusual cases. Most petioles are basically terete and barely to obviously flattened above (D-shaped) and may have a small median adaxial groove. In *Thoracocarpus* and a few species of *Asplundia* the sheath reaches all the way to the base of the blade so the leaves lack a petiole. The petioles of *Schultesiophytum* are asymmetrically D-shaped with one margin rounded and the other sharply angled. The color of the stem cross section may also be taxonomically significant; in certain species of *Asplundia* and *Dicranopygium* cut stems rapidly turn reddish brown (perhaps indicating high concentrations of tannin).

Fertile structures. The infloresences of cyclanths are monoecious and protogynous. Their most conspicuous stage—when the staminodia are exserted—is also the most ephemeral. Varying in size and color, the vermicellilike staminodia may harbor taxonomic structure but have not been used because they are so seldom seen and poorly preserved on drying. When an inflorescence with mature staminodia is collected, field notes should include color and approximate length of staminodia. The number of spathes serves to distinguish taxa but is often difficult to count on herbarium material without damaging it. Field notes should mention the number, color, and texture of spathes. Most of these time-consuming measurements can be delayed (and many more characters accurately preserved) by preserving inflorescences in liquid. Dried material of these extremely succulent parts so misrepresents the living condition that, except for well-known species, collectors are strongly urged to preserve inflorescences or parts thereof in 70% EtOH.

The color of mature fruits is variable and should be noted. They may be white, red, yellow, or green at maturity. In *Sphaeradenia* the color of mature seeds is also variable and should be recorded.

MOUNTING THE SPECIMENS

All of the foregoing discussion, especially on artful folding, is to no avail if the dried material is mounted upside down. Collectors always assume that their material will be mounted the way they pressed it, with the numbered side of the newsprint equal to the up side of the specimen. However, once the connection between newspaper and plant is broken, as it can easily be with so many steps between collecting and mounting, and as it always is in the end, the decision must be made: which side is up? Responsibility for this final important step rests upon the mounter.

In the end, a liberal use of string and judicious use of glue can obviate even this decision. Generally, one need glue down only the first layer of leaf fold and then tie the stem and petiole(s) at appropriate places (see Figs. 5, 8). In this way the specimen can be unfolded partly or completely, and both sides of the leaf can be easily examined.

Mounters, of course, will continue to receive material gathered by those who have missed, ignored, or forgotten this guide, or who are not artists. If parts are missing, or no mark records the point of division, nothing can be done. But when the leaves have been folded improperly, this guide is especially for the mounters, who with a little care can salvage the specimen and enjoy the art.

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